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STATE OF CALIFORNIA
AIR RESOURCES BOARD

CHAPTER 27

CALIFORNIA LEAD CONTROL STRATEGY

REVISION
TO THE
STATE OF CALIFORNIA
IMPLEMENTATION PLAN
FOR THE
ATTAINMENT AND MAINTENANCE OF
AMBIENT AIR QUALITY STANDARDS

SEPTEMBER 1979

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STATE OF CALIFORNIA
IMPLEMENTATION PLAN

for the

ATTAINMENT AND MAINTENANCE
OF AMBIENT AIR QUALITY STANDARDS

Adopted by the

California Air Resources Board
September 27, 1979

Mary Nichols, Chairwoman
Dr. Marjorie Evans, Board Member
Dr. Laurence Caretto, Board Member
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I. SUMMARY AND RECOMMENDATIONS

On October 5, 1978, the Environmental Protection Agency (EPA) promulgated a National Ambient Air Quality Standard for lead of 1.5 micrograms per cubic meter ($\mu g/m^3$) on a quarterly average basis. This plan has been prepared in response to a federal requirement that states prepare a plan to demonstrate attainment by 1982. Section 110(e) of the Clean Air Act permits a two year extension of the attainment date.

The national air quality standard for lead is exceeded in six of California's 14 air basins. Ambient lead levels are particularly high throughout the South Coast Air Basin. The maximum levels of lead reached in those air basins exceeding the lead standard from 1974-1977 are as follows:

	High Reading $\mu g/m^3$ (Calendar Quarter)	Year
South Coast Air Basin	7.52	1976
San Joaquin Valley	4.83	1976
San Francisco Bay Area	4.13	1976
San Diego	3.25	1976
South Central Coast	2.84	1976
Sacramento	2.11	1976

Approximately 98% of the lead emissions in California originate from the combustion of gasoline containing lead additives. On February 19, 1976, the California Air Resources Board adopted Section 2253 in Title 13 of the California Administrative Code which regulated the average lead content permitted in gasoline. California is projected to attain the National Ambient Air Quality Standard (NAAQS) for lead at all monitoring locations in the state, except for Fresno and Los Angeles Counties, by 1982 as a result of the gradual reduction in the lead content of gasoline. Attainment of the standard in Los Angeles and Fresno Counties will require localized control strategies to reduce vehicle emissions in certain "hot spots." California is therefore requesting with this SIP revision an extension of the attainment of the standard for the San Joaquin Valley and South Coast Air Basins until no later than 1984.

The Board at its hearing on September 27, 1979 took the following actions:

A. Local Control Strategies for Fresno and Los Angeles Counties

The Board requests the nonattainment lead agencies for Fresno County and for the South Coast Air Basin to develop specific local area control strategies to demonstrate attainment of the standard in 1984 in hot spot locations. The control strategies will be considered by the Board for adoption as SIP revisions. Specifically, the Board requests:

1. The Southern California Association of Governments (SCAG) and the South Coast Air Quality Management District to submit to ARB:

    a) By December 30, 1979, a work program to develop a lead control strategy.

    b) By September 30, 1980, an air quality analysis of hot spot locations.

    c) By December 31, 1981, a control strategy for the South Coast Air Basin to demonstrate attainment of the lead standard by 1984.

2. A reanalysis of future concentrations of lead be completed by ARB staff and the Fresno County NAP lead agency. If after further analysis it is determined that additional control measures for attainment of the lead NAAQS by 1984 are in fact necessary, the ARB staff will work with the Fresno County NAP lead agency to submit a control strategy to demonstrate attainment of the standard by 1984 to the ARB by December 31, 1981.

The analyses for these areas should examine areas of measured high concentrations as well as areas of suspected high concentrations due to location near major trafficways or other lead sources. In addition, in developing the analysis and control strategy, the particular vehicle mix at areas of high lead concentrations should be considered. Analysis for lead can be correlated with carbon monoxide analysis since the source emissions and the nature of the pollutants are similar.

B. <u>Integrate Consideration of Lead into all 1982 Urban Control Strategies for CO and Ozone</u>

The ARB and local districts are undergoing changes in the overall air monitoring network for all pollutants including lead. It is possible that higher concentrations of lead may be recorded as locations of monitors change to meet EPA criteria. For this reason, the ARB requests local agencies preparing 1982 attainment plans review the control strategy in their area for lead to insure progress toward attainment of the standard, to incorporate additional local controls if needed, and to coordinate those controls with compatible controls for other pollutants.

C. Reduce Exposure to Present High Concentrations of Lead

EPA based the national ambient air quality standard (NAAQS) for lead on the effects of lead on the most sensitive age group -- children between the ages of 1 and 5. A recent study by the Department of Health Services has indicated that in certain areas of the South Coast Air Basin, 20 percent of the children have elevated levels of lead in their blood.* The Department is reviewing various sources of lead in the environment, including dirt and air, to determine how to deal with these elevated levels. There are areas in the South Coast Air Basin that have had excessive levels of lead for several years and which are not projected to attain the standard by 1982. These high concentrations over long periods have resulted in high concentrations of lead in the soil near heavy traffic areas. Even in those areas projected to attain the standard by 1982, there will be continued exposure to high levels of lead during the 1979-82 period. Health officials need to address the continued effects of this exposure on small children in high risk areas and take steps to mitigate these effects during this interim period.

Discussions with the Department of Health Services have led to the following recommendations for dealing with the lead air quality problem in the near term:

(1) The State Department of Health Services should continue its lead screening program and work with local health agencies, regional transportation planning agencies, and local traffic engineers to map the locations of estimated high concentrations of lead.

(2) School districts should identify schools for kindergarten and primary school age children located in presently or historically high lead areas and should have tests done at these sites to determine the present concentrations of lead in the soil.

(3) School districts should work with the Department of Health Services to mitigate the effects of high lead concentrations.

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*Progress Report on the Childhood Lead Project, California Department of Health Services, Volume I, June 5, 1979, page 3.

(4) Local and county planning agencies should stipulate a lead soil check before the future location of pre-schools, nurseries, kindergartens, primary schools, and parks and playgrounds for young children is decided upon. In locations of high soil and/or air concentrations of lead, the location should be denied or effective mitigation measures implemented.

(5) The Department of Health Services should develop educational materials to give to parents in areas with high concentrations of lead so that they may protect their children from the lead in the dirt, in their yards and school areas, and from lead in the air.

These recommendations will be forwarded to the Department of Health Services and local agencies for their consideration and any action they deem appropriate.

II. INTRODUCTION

This document has been prepared in response to the National Ambient Air Quality Standard (NAAQS) for lead that was promulgated by the EPA on October 5, 1978. That standard has been set at 1.5 $\mu g/m^3$ averaged over a calendar quarter.

Although the national lead standard is new, California has had a state air quality standard for lead since November 1970.* The state standard is 1.5 $\mu g/m^3$ averaged over 30 days, somewhat more stringent than the national standard. Because of the existence of the state standard, California has had an air quality surveillance program for lead since 1968 in metropolitan areas, and since the mid 1970's in smaller cities.

The state also has implemented a control strategy to achieve the state standard. In 1976, the Air Resources Board (ARB) adopted regulations controlling the average amount of lead permitted in gasoline which is refined for sale in California. Beginning January 1, 1977, these regulations (Appendix D) have incrementally reduced the gasoline pool average lead content from 1.4 gms/gal to the present level of approximately 0.7 gms/gal. On January 1, 1980, the average lead content is scheduled to drop to approximately 0.5 gm/gal.

These regulations are unique in the nation, and are substantially more stringent than the lead phasedown schedule required under current federal regulations. Recently proposed changes to the proposed federal lead phasedown schedule would make it virtually impossible to achieve the lead NAAQS by 1982, were it not for the more stringent state control strategy.

This plan includes a discussion of the health impacts of lead emissions (Section III-A), the sources of lead emissions in California (Section IV), and California's existing control strategies to reduce lead emissions (Section V). The plan also includes an analysis of the ability of the control strategy to demonstrate attainment of the NAAQS (Section VI), and the air quality monitoring network which will be used to verify attainment of the standard and to develop localized control strategies for Los Angeles and Fresno Counties (Section VIII).

Finally, two locally developed plans for the attainment and maintenance of the NAAQS for lead prepared by the San Diego Air Pollution Control District (APCD), and the Bay Area Air Quality Management District (AQMD) are included as Appendix C.

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*1. Recommended Ambient Air Quality Standards applicable to all air basins. A report to the California Air Resources Board by the Technical Advisory Committee. Spetember 1970.
2. Proposed revisions of and addition to the ambient air quality standards. October 1970.
3. See also: "Report on Reconsideration of the Ambient Air Quality Standard," Mary Nichols, Air Resources Board, January 15, 1976.

III. EFFECTS OF LEAD ON HEALTH

A. General Discussion of Health Effects

Much information exists in the literature regarding the effects of lead on humans and their environment. No attempt will be made here to duplicate this effort. A short summary is, however, provided. More in depth information regarding biological and adverse health effects of lead is included in the Environmental Protection Agency (EPA) document entitled "Air Quality Criteria for Lead."*

Lead and lead components have become distributed widely throughout the natural environment. Airborne lead is deposited on the surface waters, plants, and soil. These potential sources can deliver lead to the human body through ingestion or inhalation. The quantities of lead absorbed via these routes are determined by such factors as the physical and chemical form of the lead, the nutritional status, metabolic activity, and previous exposure history of those exposed. It is estimated that inhaled lead, in the form of small particles, is absorbed by the lung between three and five times more efficiently than ingested lead is absorbed by the intestinal tract.**

In children, approximately 40% of the lead taken into the gastrointestinal tract is absorbed, whereas the corresponding value for adults is about 10%. Because of higher metabolic activity, children also inhale relatively more airborne lead than do adults. Children are also more likely to ingest lead from paint or soil. For these reasons, young children are considered to be the most sensitive population to the dangers of elevated levels of lead in the body. Some children have historically been exposed to high levels of lead, since many schools and playgrounds are located near freeways and major traffic arteries.

The body retains some of the lead that is inhaled or ingested and the continued build-up of lead to high levels over long periods of time can seriously affect health. Long term exposure to elevated lead levels can result in kidney disease, damage to the nervous system, and an increased likelihood of death from brain disorders. Red blood cells, the formation of hemoglobin, and liver function can also be affected. Hyperactivity can be one symptom of lead poisoning. In addition, lead has been shown to affect the normal functions of the reproductive, endocrine, hepatic, cardiovascular, immunologic, and gastrointestinal systems.

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*U.S. EPA Air Quality Criteria Document for Lead, December 1977.

**Fundamentals of Air Pollution. Williamson, S.J.
Addison-Wesley Publishing Co., page 329.

B. Derivation of National Ambient Air Quality Standard

The national ambient air quality standard for lead was established by estimating the concentration of lead in the air to which all groups within the general population could be exposed for protracted periods without an unacceptable risk to health.

This estimate was based on EPA's judgment in four key areas:

(1) Determining the "sensitive population" as that group within the general population which has the lowest threshold for adverse effects or greatest potential for exposure. EPA concluded that young children, aged 1 to 5, constitute the sensitive population.

(2) Determining the safe level of total lead exposure for the sensitive population, indicated by the concentration of lead in the blood. EPA concludes that the maximum safe level of blood lead for an individual child is 30 μg Pb/dl* blood, and that population blood lead concentrations, measured as the geometric mean, must be at or below 15 μg Pb/dl in order to place 99.5 percent of children in the United States below 30 μg Pb/dl.

(3) Attributing the contribution to blood lead from non-airborne sources. EPA concluded that 12 μg Pb/dl of population blood lead for children should be attributed to nonair exposure.

(4) Determining the air lead level which is consistent with maintaining the mean population blood lead level at 15 μg Pb/dl. Taking into account exposure from other sources (12 μg Pb/dl) EPA has designed the standard to limit air contribution after achieving the standard to 3 μg Pb/dl. On the basis of an estimated relationship of air lead to blood lead of 1 to 2, EPA concluded that the ambient air quality standard should be 1.5 μg/m^3.

EPA's originally proposed a lead standard of 1.5 μg/m^3 over a 30-day averaging period, the same averaging period set for the state standard. When EPA finally promulgated the lead standard, the agency changed the averaging time to a calendar quarter. The reasoning behind this decision can be found in the following excerpt from the Federal Register of October 5, 1978.

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*The deciliter (dl) is a standard volume of blood normally taken for analysis of blood lead content.

"EPA accepts the consensus of comments received on the scientific and technical difficulties presented by the selection of a calendar month averaging period. The Agency believes that the key criterion for the averaging period is the protection of health of the sensitive population. In proposing the 1.5 μg/m^3 standard, EPA concluded that this air level as a ceiling would be safe for indefinite exposure of young children. The critical question in the determination of the averaging period is the health significance of possible elevations of air lead above 1.5 μg/m^3 which could be sustained without violation of the average of 1.5 μg/m^3. In the proposed standard, EPA chose a monthly averaging period on the basis of a study showing an adjustment period of blood lead level with a change of exposure (Griffin et al.*). Because of the scientific and technical difficulties of the monthly standard, EPA has reexamined this question and concludes that there is little reason to expect that the slightly greater possibility of elevated air lead levels within the quarterly period is significant for health. This conclusion is based on the following points:

(1) From actual ambient measurements, the distribution of air lead levels is such that where the quarterly standard is achieved, there is little possibility that there could be sustained periods greatly above the average value.

(2) While it is difficult to relate the extent to which a monitoring network actually represents the exposure situation for young children, it seems likely that where elevated air lead levels do occur, they will be close to point or mobile sources of lead air pollution. Typically, young children will not encounter such levels for the full 24-hour period reported by the monitor.

(3) There is medical evidence indicating that blood lead levels reequilibrate slowly to changes in air exposure. This serves to dampen the impact of a short-term period of exposure to elevated air lead.

(4) Direct exposure to air is only one of several routes of total exposure. This lessens the impact of a change in air lead on blood lead levels.

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*Griffin, T. B., F. Coulston, H. Wills, J. C. Russel, and J. H. Knelson. Clinical studies on men continuously exposed to airborne particulate lead. Environ. Qual. Safety Suppl. 2:221-240, 1975.

On balance, the Agency concludes that a requirement for the averaging of air quality data over a calendar quarter will improve the validity of air quality data gathered without a significant reduction in the protectiveness of the standard."

IV. SOURCES OF LEAD EMISSIONS IN CALIFORNIA

Lead is important to the U.S. economy, ranking fourth among the nonferrous metals in tonnage used. Approximately 85 percent of the primary lead used in this country is produced from native mines, however, no mining for lead is done in California.

Lead is a metal with a wide variety of uses. Nationwide uses of lead by major product categories are shown in Table 27-1 and Figure 27-1. Certain products, especially batteries, cables, plumbing, weights, and ballast, contain lead that is economically recoverable as secondary lead. Lead in pigments, gasoline additives, ammunition, foil, solder, and steel products is widely dispersed and therefore is largely unrecoverable.

The largest source, by far, of lead emissions to the atmosphere is the exhaust from motor vehicles powered by gasoline that contains lead additives. These mobile-source emissions collectively constitute an estimated 98 percent of total lead emissions in California (Table 27-2). Other mobile sources, including diesel fuel combustion for trucks and railroads, contribute statistically insignificant lead emissions to the atmosphere.*

"Lead particulates emitted in automotive exhaust may be divided into two size classes. Particles initially formed by condensation of lead compounds in the combustion gases are quite small in size (well under 0.1 μm in diameter). Particles in this size category that become airborne can remain suspended in the atmosphere for long periods and thus can travel substantial distances from the original sources. Figure 27-2 shows the results of research on the changes in lead concentrations with distance downwind from a highway. Larger particles are also formed as a result of agglomeration of smaller condensation particles."**

"These larger particles, which may be tens of microns or larger in diameter, behave in the atmosphere like the larger lead particulates emitted from most stationary sources and fall to the ground in the vicinity of the traffic producing them. The distribution of lead exhaust particles between the smaller and larger size ranges appears to depend on a number of factors, including the particular driving pattern in which the vehicle is used and its past driving history. But as an overall average, it has been estimated that during the lifetime of the vehicle, approximately 35 percent of the lead contained in the gasoline burned by the vehicle will be emitted as fine particulate, and approximately 40 percent will be emitted as coarse particulate. The remainder of the lead consumed in gasoline combustion is deposited in the engine and exhaust system. Engine deposits are in part, gradually transferred to the lubricating oil and removed from the vehicle when the oil is changed."**

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*U.S. Environmental Protection Agency, Air Quality Criteria for Lead, EPA-600/8-77-017, December 1977.

**Air Quality Criteria Document for Lead. EPA-600/8-77-017. December 1977.

TABLE 27-1. U.S. CONSUMPTION OF LEAD*
(in short tons)

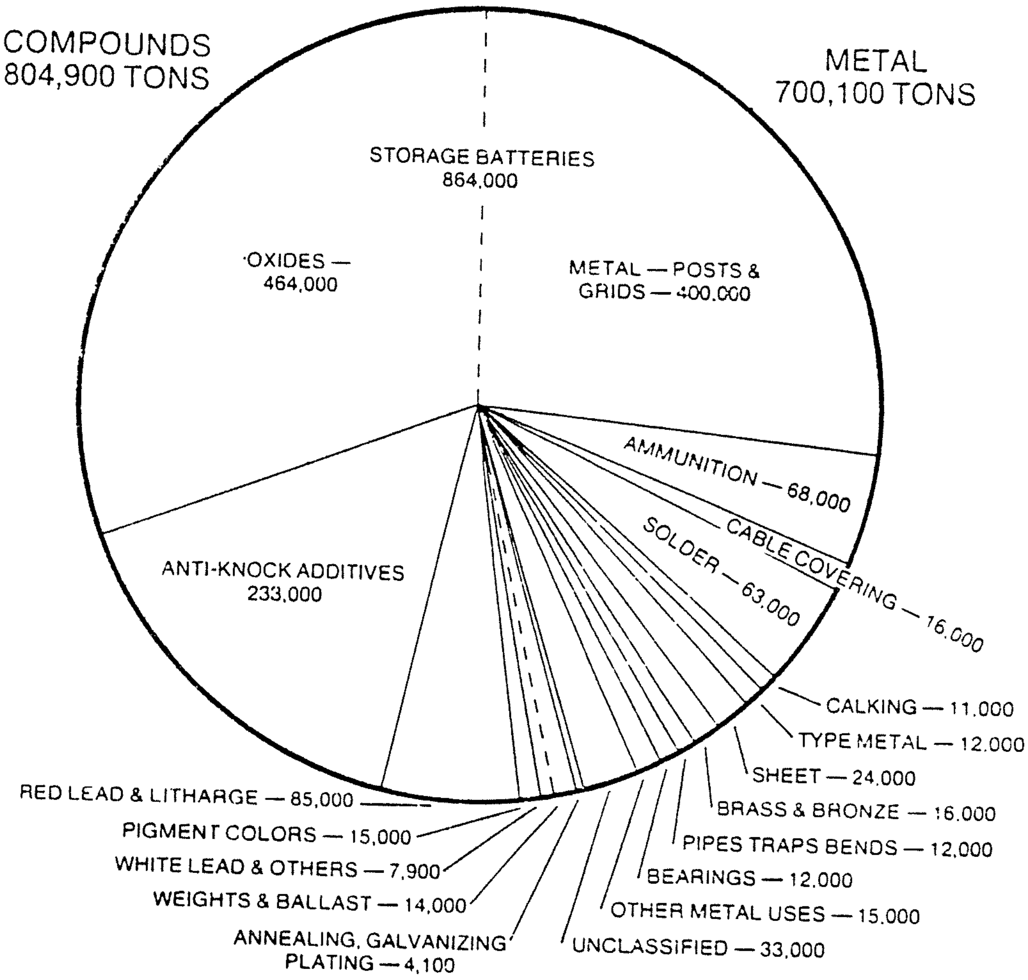
	1973	1974	1975	1976	1977 est.
Ammunition	81,479	87,090	75,081	73,478	68,000
Bearing metals	15,657	14,609	12,184	13,063	12,000
Brass and bronze	22,735	22,240	13,404	15,660	16,000
Cable covering	43,005	43,426	22,099	15,930	16,000
Calking lead	20,057	19,739	14,296	12,475	11,000
Casting metals	7,220	7,507	7,711	6,708	6,000
Collapsible tubes	2,860	2,488	2,216	2,329	2,100
Foil	4,985	4,404	3,205	5,126	4,100
Pipe, traps and bends	21,291	16,455	14,233	13,789	12,000
Sheet lead	23,394	21,294	24,859	24,438	24,000
Solder	71,770	66,280	57,344	63,324	63,000
Storage Batteries	769,447	851,881	699,414	822,404	564,000
Terne metal	2,658	2,300	1,511	1,595	2,300
Type metal	21,922	20,516	16,211	15,007	12,000
White lead	1,749	1,996	2,498	2,993	7,200
Red lead and litharge	89,577	96,163	65,457	85,403	85,000
Pigment colors	16,963	17,336	10,618	16,634	15,000
Other	477	718	499	561	700
Gasoline antiknock additives	274,410	250,502	208,605	239,758	233,000
Misc. chemicals	944	708	181	146	500
Annealing	3,974	4,097	2,629	2,893	2,500
Galvanizing	1,294	1,664	1,228	1,252	1,200
Lead plating	744	498	376	386	400
Weights and ballast	20,848	21,418	20,018	22,366	14,000
Other Uses unclassified	21,749	24,098	21,221	32,354	33,000
TOTAL	1,541,209	1,599,427	1,297,098	1,490,072	1,505,000

* U.S. Bureau of Mines

SOURCE: Lead Industry Association, Inc. Annual Review 1977.

Figure 27-1

UNITED STATES
LEAD CONSUMPTION BY PRODUCT - 1977
TOTAL: 1,505,000 SHORT TONS



SOURCE: Lead Industries Association, Inc. Annual Report 1977.

TABLE 27-2

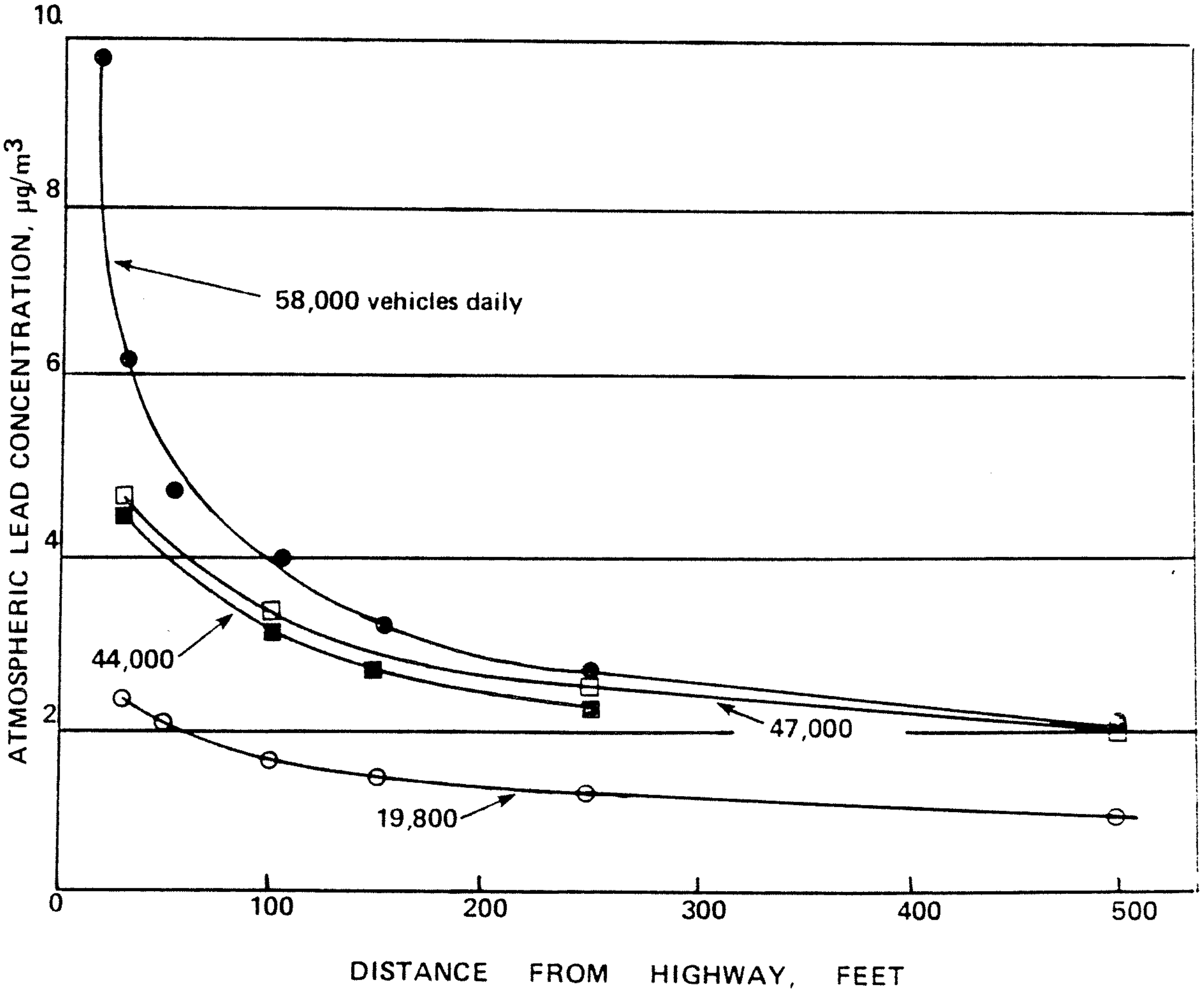
RELATIVE CONTRIBUTION OF LEAD EMISSIONS IN CALIFORNIA BY USE - 1977

	Tons/year	Percent
Gasoline combustion	13,987	97.6
Combustion of fuel oil at power plant	35	0.2
Combustion of fuel oil at other sources	24	0.2
Steel and iron furnaces and cupolas	10	0.1
Battery manufacture	6	0.04
Brass-bronze furnaces	6	0.04
Secondary lead furnaces	5	0.03
Tetra-ethyl lead mfg.	4	0.02
Coal combustion	2	0.01
Soldering	.5	0
Marketing	1.5	.01
Lawn and utility	120	0.8
Farm equipment	21	0.1
Heavy duty equipment	116	0.8
	14,338	99.94

SOURCE: California Air Resources Board, Technical Services Division.

Figure 27-2

VARIATION IN ATMOSPHERIC LEAD CONCENTRATION WITH TRAFFIC VOLUME AND DISTANCE FROM THE HIGHWAY



From "Atmospheric Lead: Its Relationship to Traffic Volume and Proximity to Highways", Robert H. Daines, Harry Motto, Daniel M. Chilko, Environmental Science and Technology, Vol. 4, No. 4, April 1970, pp 318-322.

The fate of spent oil and its lead content is of importance since much of the waste oil is ultimately combusted by other sources emitting lead to the atmosphere. Waste oil is burned as fuel in industrial and utility boilers as a means of disposal and for recovery of economic and energy values. The major source of waste oil is automotive lubricants such as crankcase oils, transmission fluids, differential gear lubricants, and hydraulic oils. It is either blended with fuel oil for use in power plants, fired directly as in rotary cement kilns, or used as supplementary fuel in smaller boilers generating steam for space heating and processing. In California, lead emissions from waste oil combustion represented less than 2% of the nonvehicular lead emissions for the state in 1978. As shown in Table 27-9, there was only one waste oil combustion source emitting more than one ton per year in 1976. (See Appendix B.)

"In addition to lead retained in lubricating oil, some of the lead deposited in the vehicle exhaust system gradually flakes off as extremely large particles, and is emitted from the exhaust. It rapidly falls out onto streets and roads where it becomes airborne as road dust, is washed into sewers or, settles on adjacent soil."

The use of lead additives in gasoline, which was increasing in total volume for many years, is now decreasing as vehicles designed to use lead-free gasoline constitute a growing portion of the total automotive population. Regulations promulgated by ARB that limit the average concentration of lead additives in gasoline will further contribute to a reduction in future automotive lead emissions. There is no limit, however, on the lead content of aviation gasoline. In 1978, total aviation gasoline production was approximately 1% of the total gasoline production for the state, containing about 3% of the total lead used as fuel additives. Near airports, aviation fuel combustion may be a significant source of airborne lead.

Lead is added to gasoline as a means of suppressing engine knock by promoting uniform burning of the air-fuel mixture in the engine combustion chambers. Although a number of chemical compounds, besides those containing lead, can provide some antiknock effectiveness, the most commonly used and the most effective are tetraethyl lead (TEL) and tetramethyl lead (TML).

Other knock suppressors include organic amines, such as aniline, which are somewhat effective but higher in cost than lead alkyls. Iron carbonyl is effective and relatively inexpensive, but the combustion products are abrasive and cause accelerated engine wear. Some organic chemicals (e.g., tertbutyl acetate) have shown a synergistic effect when added to leaded gasoline. Such compounds give an increase in octane number greater than would be expected from the individual effects of the compound and the lead alkyl.

Aside from the use of certain additives, the octane rating of gasoline can be increased through additional refining processes. One effect of this method is that slightly less gasoline per barrel of crude oil is produced while production of other petroleum products is increased.

V. EXISTING PROGRAMS FOR LEAD CONTROL

A number of federal, state, and local programs designed to limit the public's exposure to lead were put in effect prior to the promulgation of the NAAQS for lead.

Current EPA regulations limit the average lead content in the total gasoline pool to 0.5 grams/gallon by October 1, 1979. The 0.5 gm/gal limit applies to the average of both leaded and unleaded grades of gasoline. Thus, a single gallon of leaded premium gasoline, for example, could contain substantially more than 0.5 grams of lead. The federal program does not control gasoline from refiners producing less than 50,000 bbls/day of gasoline or facilities which are owned or controlled by a refiner with a total combined crude oil or feed stock capacity of 137,500 barrels per day or less. The table below illustrates the scheduled federal phasedown of lead in gasoline. Recently, however, as a response to the nationwide gasoline shortage, EPA has proposed a relaxation of these regulations for a period of at least one year.

Federal Phasedown of Lead in Gasoline

Effective Date of Limitation	Pool Average Maximum Lead Content (gm/gal)
January 1, 1978	0.8
October 1, 1979	0.5

ARB regulations* (see Appendix D) limit the average lead content of gasoline to 0.4 grams/gallon by January 1, 1980 for refiners producing more than 20,000 bbls/day and 1.4 grams/ gallon for refiners producing less than 20,000 bbls/day of gasoline. Like the federal limits, the state lead standards apply to the average of both leaded and unleaded gasolines. Compliance with this regulation is checked by having each California refiner submit to the ARB a quarterly report showing 1) the total grams of lead in the lead additive inventory on the first day of the reporting period, 2) the total grams of lead received during the period, 3) the total grams of lead in the lead inventory on the last day of the period, 4) the total gallons of gasoline produced by each refinery during the period, 5) the average lead content in each gallon of gasoline produced during the period, and 6) any other information, including data on gasoline imported to or exported from the state, as may be required by the ARB to ascertain the lead content of gasoline to be sold at retail in California. The following table shows the schedule of California's phasedown of lead in gasoline.

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*Section 2253 in Title 1(e) of the California Administrative Code.

California Phasedown of Lead in Gasoline

Effective Date of Limitation	Pool Average Maximum Lead Content (gm/gal)
For refiners producing more than 20,000 bbl/day:	
January 1, 1977	1.4
January 1, 1978	1.0
January 1, 1979	0.7
January 1, 1980	0.4
For refiners producing less than 20,000 bbl/day:	
January 1, 1979	1.7
January 1, 1980	1.4

The Bay Area Air Quality Management District has adopted, and the ARB has previously submitted to EPA as an SIP revision, a rule (Division 12, Regulation 2) which establishes a ground level concentration limit for lead, and further specifies certain monitoring requirements to ensure that those limits are met.

In July 1977, the California Department of Health embarked on a two-year project to determine the extent and nature of the problem posed by environmental lead to the children of California. It found that "environmental lead poses a real hazard to the health of children in most socioeconomic levels and geographic areas of California where screening has been conducted."*

In 1975 a national interim primary drinking water standard was promulgated setting a maximum contaminant level for lead.

State regulations require the addition of coloring agents to the pesticide lead arsenate and specify disposal procedures for lead pesticides. However, the use of lead in pesticides is a small and decreasing proportion of total lead consumption in California. The amount of pesticide lead arsenate applied in California as reported by the State Department of Food and Agriculture in its Annual Pesticide Use Reports were 9250 pounds in 1976, and only 77 pounds in 1977 and 22 pounds in 1978.

The Department of Housing and Urban Development (HUD) has requirements for reducing human exposure to lead through the prevention of lead poisoning from ingestion of paint. Their activities include (1) prohibition of the use of lead-based paints on structures constructed or rehabilitated through federal funding and on all

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*Progress Report on the Childhood Lead Project, California Department of Health Services, June 5, 1979.

HUD-associated housing; (2) the elimination of the immediate hazard from lead-based paint; (3) notification of purchasers of HUD-associated housing constructed prior to 1950 which may contain lead-based paint; and (4) research activities to develop improved methods of detection and elimination of lead-based paint hazards, and to determine the nature and extent of lead poisoning.

The Consumer Product Safety Commission (CPSC) promulgated regulations in September 1977 which ban: (1) paint and other surface coating materials containing more than 0.08 percent lead; (2) toys and other articles intended for use by children bearing paint or other similar surface coating material containing more than 0.06 percent lead; and (3) furniture coated with materials containing more than 0.06 percent lead. These regulations are based on CPSC's conclusion that it is in the public interest to reduce the risk of lead poisoning to young children from ingestion of paint and other similar surface coating materials.

The Food and Drug Administration (FDA) uses, as a working guideline which was published as a proposal in 1974, a tolerance for lead of 0.3 ppm in evaporated milk and evaporated skim milk. This tolerance is based on maintaining children's blood lead levels below 40 μg Pb/dl. FDA has also proposed an action level of 7 μg Pb/ml for leachable lead in pottery and enamelware although the exact contribution of such exposure to total human dietary intake has not been established.

VI. AIR QUALITY ANALYSIS

A. Assumptions

The air quality analysis used to project attainment of the standards is based on several assumptions related to future lead use and air quality impacts.

The major assumption in the analysis is the continuation of the existing program to reduce the average lead content of gasoline in California. As noted earlier, the lead phase-out program in California was established in 1975. These regulations have incrementally reduced the level of lead from 1.4 gms/gal in 1977 to the present level of 0.7 gm/gal. On January 1, 1980, the average lead content is scheduled to drop to approximately 0.5 gm/gal.

On May 17, 1979, a public hearing was held by the ARB to consider temporary modifications to the lead regulations to enable refiners to produce more gasoline and ease the gasoline shortages that California was experiencing. The Board, on an emergency basis, decided to allow the Executive Officer to grant refiners a waiver of the lead content regulations between the period May 18, 1979 and September 30, 1979 under certain conditions. These will have no effect on the ultimate effectiveness of the control strategy since the schedule remains unchanged to reduce the lead content to 0.4 grams per gallon by 1982. The May to September period in which waivers were allowed has historically had the lowest concentrations of lead in the ambient air. The temporary relaxation of the lead regulations does not violate any of the assumptions made for the analysis. Furthermore, the state commits that consideration of future similary emergency actions will be made in the context that such actions not be allowed to interfere with the attainment and maintenance of the lead NAAQS.

Another assumption made in the anlaysis is that the growtn in vehicle miles travelled (VMT) will be as assumed in the various area nonattainment plans developed during 1977 and 1978.

A third assumption is the use of a "natural" background concentration of 0.02 $\mu g/m^3$. This level was determined by measurements of lead levels in a nonurban area of California (White Mountain) not significantly influenced by stationary or mobile lead sources.*

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*Chow, T. J., J. L. Earl, and C. B. Snider. Aerosol Baseline: Concentration at White Mountain and Laguna Mountain, California Science 1972, page 401.

The air quality analysis itself is based on the highest measured concentration during the past several years in each area analyzed. It is possible that future changes in monitoring locations may result in somewhat different readings.

The ARB emissions inventory and projections for lead are used in the analysis are based on the following assumptions:

1. Unleaded gasoline contains 0.05 gm/gal lead (the maximum allowable limit under federal regulations).

2. The lead content of leaded gasoline is the maximum level which can be used consistent with the state's pool average lead limits. For example, in 1982 the lead content of leaded gasoline is assumed to be about 1.2 grams per gallon.

3. In any given year, large refineries (more than 20,000 barrels/day) produce 88% of the total gasoline. The remaining 12% of the gasoline is produced by small refineries (less than 20,000 barrels/day). These estimates are based on quarterly gasoline production reports submitted to the ARB by all refiners during 1978.*

4. All post-1974 passenger cars and all post-1975 light-duty trucks use unleaded gasoline. In reality, a small fraction of post-74 cars are designed to use leaded gasoline, and a small fraction of pre-1975 model cars use unleaded gasoline voluntarily.

5. All post-1977 medium-duty vehicles use unleaded gasoline.

6. All lead burned in motor vehicle engines is exhausted into the atmosphere. This simplifying assumption makes the results somewhat conservative since it is known that some lead is retained in the motor vehicle exhaust system or is accumulated in engine oil and emitted during combustion by some other source.

7. Diesel-powered vehicles are assumed to emit quantities of lead that are insignificant compared to gasoline-powered vehicles.

B. Past and Current Emissions and Air Quality

The NAAQS for lead is currently exceeded in many parts of the state. Since the major source of airborne lead in California is the combustion of gasoline in motor vehicles, areas with little or no industry involving lead compounds still exceed the standard.

A summary of lead air quality data for the period 1974 through 1977 (Table 27-3) was used to evaluate compliance with the new national standard. The annual average, the maximum calendar quarter average, the minimum calendar quarter average, and the number of calendar quarters when the average lead concentration exceeded 1.50 $\mu g/m^3$ are listed by air basin and station for each year. The number of calendar quarters with sufficient lead concentration data to determine a representative average is listed in parentheses in those cases where fewer than four representative calendar quarters of data were available.

Figure 27-3 shows average lead concentrations for groups of cities of similar population size. Three year running averages are shown superimposed on the plot of each group's annual mean lead concentrations. The three year average reduces the fluctuations caused by the year to year variations in meteorology and emissions. The period of record of the smallest cities is shorter because monitoring of lead began first in the metropolitan areas and was only extended to small cities in the mid 1970's. The data in Figure 27-3 are shown only to assess historical trends and were not actually used as the basis for the air quality analysis.

The highest recorded levels of lead occur in the winter when the nights are longer than any other time of year and there is a greater potential for radiation cooling. This results in more stable air near the ground surface and a reduction in atmospheric turbulence. As atmospheric turbulence is reduced the degree of mixing and dilution is likewise reduced allowing higher concentrations of lead to accumulate. This effect is graphically shown in Table 27-3 which indicates average monitored readings by calendar quarter.

Because in California the highest lead levels are generally recorded in November, December, and January, the calendar quarter averaging period mandated by the national standard may not reveal the highest 90-day periods of exposure. Thus, attainment of the state's 30-day average lead air quality standard may more closely approximate the intent of EPA as described in Section III(B) above.

Table 27-5 (see Appendix B) is an emissions inventory, by county, of non-mobile sources of lead in California. For 1977 the total of non-mobile lead sources was less than 3% of the lead emitted statewide. The remaining 97% originates from gasoline combustion in the automobile. Since non-mobile sources are such a small part of the problem inventories for these sources for the various base years (1975 - 1977) were assumed to be constant.

TABLE 27-3

AMBIENT LEAD DATA SUMMARY 1974-1977

LEAD SUMMARY, 1974 - 1977

Basin-Station	1974 Annual Avg.	1974 Quarter* Avg. Max	1974 Quarter* Avg. Min	1974 Number > 1.50 µg/m³	1975 Annual Avg.	1975 Quarter* Avg. Max	1975 Quarter* Avg. Min	1975 Number > 1.50 µg/m³	1976 Annual Avg.	1976 Quarter* Avg. Max	1976 Quarter* Avg. Min	1976 Number > 1.50 µg/m³	1977 Annual Avg.	1977 Quarter* Avg. Max	1977 Quarter* Avg. Min	1977 Number > 1.50 µg/m³
NORTH COAST																
Calpella	0.40	0.49	0.31	0 (3)	-	-	-	-	-	-	-	-	-	-	-	-
Fort Bragg	0.43	0.57	0.34	0 (3)	-	-	-	-	0.39	0.36	0.36	0 (2)	0.37	0.40	0.35	0
Willits	0.34	0.36	0.32	0 (3)	-	-	-	-	-	-	-	-	-	-	-	-
SAN FRANCISCO BAY AREA																
Burlingame	0.73	1.22	0.26	0	0.70	0.75	0.27	0 (3)	1.21	2.03	0.69	1	0.83	1.28	0.39	0
Concord	0.55	1.01	0.22	0	0.53	0.91	0.22	0	1.18	2.26	0.55	1	0.89	1.49	0.48	0
Fremont	0.76	1.03	0.43	0	1.03	1.47	0.48	0	1.25	1.67	0.86	1	1.10	1.48	0.58	0
Gilroy	-	-	-	-	-	-	-	-	0.93	1.87	0.48	1	0.88	1.33	0.36	0
Livermore	0.73	1.12	0.30	0	0.79	1.22	0.39	0	1.12	1.99	0.62	1	0.83	1.16	0.54	0
Napa	0.75	1.32	0.29	0	0.95	1.48	0.43	0	1.36	2.01	0.84	2	0.91	1.48	0.49	0
Pittsburg	0.34	0.53	0.20	0	0.38	0.61	0.18	0	0.81	1.35	0.30	0	0.56	0.90	0.31	0
Redwood City	0.83	1.37	0.34	0	0.86	1.07	0.48	0	1.36	2.61	0.68	1	0.89	1.48	0.50	0
Richmond	0.46	0.92	0.21	0	0.47	0.88	0.17	0	0.96	1.86	0.55	1	0.73	0.98	0.52	0
San Francisco	1.55	1.96	0.87	2	1.67	2.15	0.68	3	2.09	2.80	1.75	4	1.30	1.83	1.00	1
San Jose	0.97	1.63	0.34	1	1.58	2.59	0.61	2	2.13	4.13	0.91	2	1.20	1.96	0.66	1
San Rafael	0.98	1.56	0.51	1	1.25	2.24	0.53	1	1.73	3.21	0.77	2	1.12	1.76	0.76	1
Santa Rosa	0.47	0.71	0.25	0	0.63	1.12	0.28	0	0.85	1.34	0.50	0	0.61	0.84	0.38	0
Sunnyvale	0.81	1.46	0.27	0	1.29	2.00	0.51	2	1.33	2.18	0.73	1	0.99	1.71	0.52	1
Vallejo	0.85	1.36	0.34	0	0.71	1.51	0.28	1	1.13	2.17	0.55	1	0.70	1.30	0.38	0
NORTH CENTRAL COAST																
Salinas	0.64	1.16	0.37	0	0.65	1.01	0.40	0	0.62	0.92	0.41	0	0.44	0.73	0.28	0
SOUTH CENTRAL COAST																
Camarillo	0.86	1.23	0.58	0	0.74	0.98	0.57	0	0.70	1.04	0.46	0	0.65	0.94	0.46	0 (2)
Paso Robles	0.89	0.89	0.89	0 (1)	0.55	0.92	0.33	0	0.67	1.26	0.32	0	0.61	0.88	0.35	0
Santa Barbara	1.48	2.11	0.83	2	1.44	2.67	0.72	2	1.64	2.84	0.87	2	1.30	2.16	0.65	2
Santa Maria	0.57	0.61	0.51	0 (3)	-	-	-	-	-	-	-	-	-	-	-	-
Simi Valley	-	-	-	-	-	-	-	-	0.96	0.96	0.96	0 (1)	1.38	1.92	0.99	1 (2)
SOUTH COAST																
Anaheim	1.95	3.25	1.12	3	2.25	3.59	1.21	3	2.34	3.49	1.48	3	2.06	3.28	1.08	2
Azusa	1.82	2.08	1.51	4	1.86	2.49	1.44	2	1.68	1.96	1.32	3	1.95	2.65	1.43	3
Big Bear Lake	-	-	-	-	-	-	-	-	0.26	0.33	0.15	0	0.54	1.66	0.20	1
Chino	-	-	-	-	-	-	-	-	2.08	3.49	1.52	4	1.90	3.08	1.34	2
Costa Mesa	1.67	2.80	0.59	1 (2)	1.68	3.51	0.55	2	1.68	3.39	0.66	2	1.45	2.66	0.39	2
El Toro	1.31	1.64	0.99	1 (2)	0.79	1.01	0.60	0 (2)	1.28	1.63	0.81	1 (3)	1.06	1.48	0.60	0
Fontana	-	-	-	-	1.45	2.07	1.01	2	1.24	1.36	1.07	0	1.14	1.61	0.85	1
Laguna Beach	1.91	2.24	1.57	2 (2)	1.89	2.90	1.16	2 (3)	1.98	3.07	1.19	3	1.84	2.09	2.09	1 (1)
La Habra	2.00	3.19	1.17	3	2.17	3.51	1.09	3	2.23	3.46	1.43	2	2.05	3.20	1.16	2
Lake Gregory	-	-	-	-	-	-	-	-	-	-	-	-	0.52	1.03	0.09	0
Lennox	4.35	6.52	2.77	4	3.80	6.77	1.57	4	4.08	7.52	1.76	4	3.47	5.35	1.56	4
Los Alamitos	2.49	3.95	1.03	1 (2)	2.38	4.24	0.85	2 (3)	2.53	4.57	1.00	2	1.97	3.25	0.75	2
Los Angeles	2.92	3.99	2.03	4	2.93	4.86	1.59	4	2.72	3.76	1.81	4	2.76	4.47	1.62	4
Lynwood	-	-	-	-	2.33	4.47	1.16	2	2.95	5.30	1.62	4	2.85	4.60	1.34	2
Ontario	-	-	-	-	-	-	-	-	2.13	2.64	1.73	3 (3)	1.23	1.91	0.71	1 (3)
Pasadena	2.16	2.76	1.55	4	2.65	4.01	1.80	4	2.89	4.49	2.10	4	3.00	4.37	1.92	4
Pico Rivera	-	-	-	-	-	-	-	-	-	-	-	-	2.98	5.52	1.40	2 (3)
Redlands	-	-	-	-	-	-	-	-	1.06	1.32	0.79	0	1.19	1.72	0.88	1
Reseda	2.63	3.27	2.13	4	2.51	4.72	1.92	4	2.30	3.37	1.60	4	2.27	3.40	1.46	3

Continued on next page

TABLE 27-3

AMBIENT LEAD DATA SUMMARY 1974-1977

LEAD SUMMARY, 1974 - 1977

Basin-Station	1974 Annual Avg.	1974 Quarter* Avg. Max	1974 Min	1974 Number [illegible]	1975 Annual Avg.	1975 Quarter* Avg. Max	1975 Min	1975 Number [illegible]	1976 Annual Avg.	1976 Quarter* Avg. Max	1976 Min	1976 Number [illegible]	1977 Annual Avg.	1977 Quarter* Avg. Max	1977 Min	1977 Number [illegible]
SOUTH COAST (COASTAL)																
Rialto		-	-		-	-	-	-	0.97	1.22	0.83	0	[illegible]	1.05	[illegible]	0
Riverside-Magnolia	2.41	3.11	1.[illegible]	1	2.39	3.03	1.78	4	2.21	3.84	1.96	4	[illegible]	3.53	[illegible]	4
Riverside-Rubidoux	2.31	2.43	[illegible]	[illegible]	1.19	1.30	0.98	3	1.47	2.31	1.05	1	[illegible]	1.98	[illegible]	2
Riverside-Trailer	-	-	-		-	-	-	-	1.80	2.20	1.31	1 [illegible]	1.[illegible]	1.91	1.31	2 [illegible]
San Bernardino	1.61	1.96	1.13	[illegible]	1.77	2.47	1.16	3	1.47	1.59	1.05	2	1.32	1.57	1.15	[illegible]
San Juan Capistrano			-		-		-		0.89	1.46	0.40	0 [illegible]	[illegible]	1.14	0.39	0
Santa Ana-Weir Canyon	-		-		1.69	2.33	1.18	2 (3)	1.71	2.53	1.19	2	1.75	2.52	1.[illegible]	2
Sky Forest	0.38	[illegible]	0.32	0	0.40	0.45	0.44	0 (2)	-	-	-		-	-	-	
Upland	-	-	-		-	-	-	-	1.72	2.08	1.38	2	1.55	1.8[illegible]	1.[illegible]	2
West Los Angeles	1.90	2.51	1.31	[illegible]	1.87	2.86	1.61	2	1.59	2.17	0.[illegible]	2	1.43	2.34	[illegible]	[illegible]
SAN DIEGO																
El Cajon	1.54	2.[illegible]	0.94	1	1.66	2.24	0.95	2	1.97	3.25	1.12	2	1.[illegible]	2.30	[illegible]	2
San Diego	1.31	1.[illegible]	0.66	2	1.26	1.96	0.62	2	1.62	[illegible]	0.62	2	[illegible]	2.61	[illegible]	[illegible]
NORTHEAST PLATEAU																
Alturas	0.21	-	-	0 (0)	-	-	-	-	0.33	0.5[illegible]	0.57	0 (1)	0.23	0.36	0.[illegible]2	0
Yreka	0.20	0.26	0.12	0 [illegible]	0.34	[illegible]	0.15	0	0.37	0.62	0.[illegible]	0	0.2[illegible]	[illegible]	[illegible]	[illegible]
SACRAMENTO VALLEY																
Red Bluff	0.33	0.30	0.28	0 (3)	0.22	0.23	0.22	0 (2)	0.51	[illegible]	0.2[illegible]	[illegible]	[illegible]	0.44	0.35	0
Sacramento	0.[illegible]	1.[illegible]	0.55	0	0.82	1.30	0.3[illegible]	[illegible]	1.15	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	0
SAN JOAQUIN VALLEY																
Bakersfield	1.81	2.93	0.98	3	1.36	3.27	0.99	3	2.25	[illegible]	0.[illegible]	2	2.26	3.92	0.[illegible]	3
Fresno	1.33	2.10	0.76	2	1.91	2.[illegible]	1.37	3	2.77	4.[illegible]	1.1[illegible]	2	2.[illegible]	3.35	1.1[illegible]	2
Madera	0.63	0.79	0.15	0 (2)	0.90	1.43	0.52	0	1.13	1.54	0.55	1 (2)	-	-	-	-
Merced	0.72	1.08	0.45	0	0.75	1.48	0.43	0 (3)	0.39	[illegible]	[illegible]	1	0.79	1.26	[illegible]	0
Merced-Trailer	0.60	0.76	0.43	0	0.79	0.93	[illegible]	0 (1)		-	-	-	-	-	-	-
SOUTHEAST DESERT																
Barstow	-	-	-				-	-	0.73	1.30	0.46	0	0.78	[illegible]	0.5[illegible]	0
El Centro	0.64	1.00	0.41	0	0.61	1.08	0.34	0	0.59	0.75	0.30	0	0.55	[illegible]	0.34	0
Indio	0.86	1.00	0.71	0 (2)	0.90	1.17	0.47	0	0.56	0.81	0.11	0	0.49	0.7[illegible]	0.[illegible]3	0
Lancaster	-	-	-	-	0.91	1.40	0.44	0	0.75	1.47	0.34	0	0.6[illegible]	[illegible]	0.25	[illegible]
Palm Springs	-	-	-	-	-	-	-	-	0.37	0.[illegible]	0.3[illegible]	0 (3)	-	-	-	-
Trona	-	-	-	-	-	-	-	-	-	-	-		0.30	0.24	0.13	0 (2)
Victorville	-	-	-	-	-	-	-	-	0.77	1.2[illegible]	0.[illegible]	0	0.[illegible]	0.71	0.[illegible]3	0
MOUNTAIN COUNTIES																
Sonora	0.84	1.0[illegible]	0.59	0	0.96	1.5[illegible]	0.61	1	1.0[illegible]	[illegible]	[illegible]	1	[illegible]	-	-	[illegible]
LAKE COUNTY																
Lakeport	0.24	0.[illegible]	0.17	0	0.1[illegible]	0.26	[illegible]	0	[illegible]	0.3[illegible]	0.12	0	0.17	0.23	0.12	0
LAKE TAHOE																
South Lake Tahoe	-	-	-	-	0.4[illegible]	-	-	1 [illegible]	0.[illegible]	[illegible]	[illegible]	0 (1)	-			-

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* Calendar quarter

( ) Denotes number of calendar quarters [illegible] that have a sufficient number [illegible]

FIGURE 27 - 3

THREE YEAR RUNNING AVERAGE OF LEAD CONCENTRATIONS BY CITY SIZE

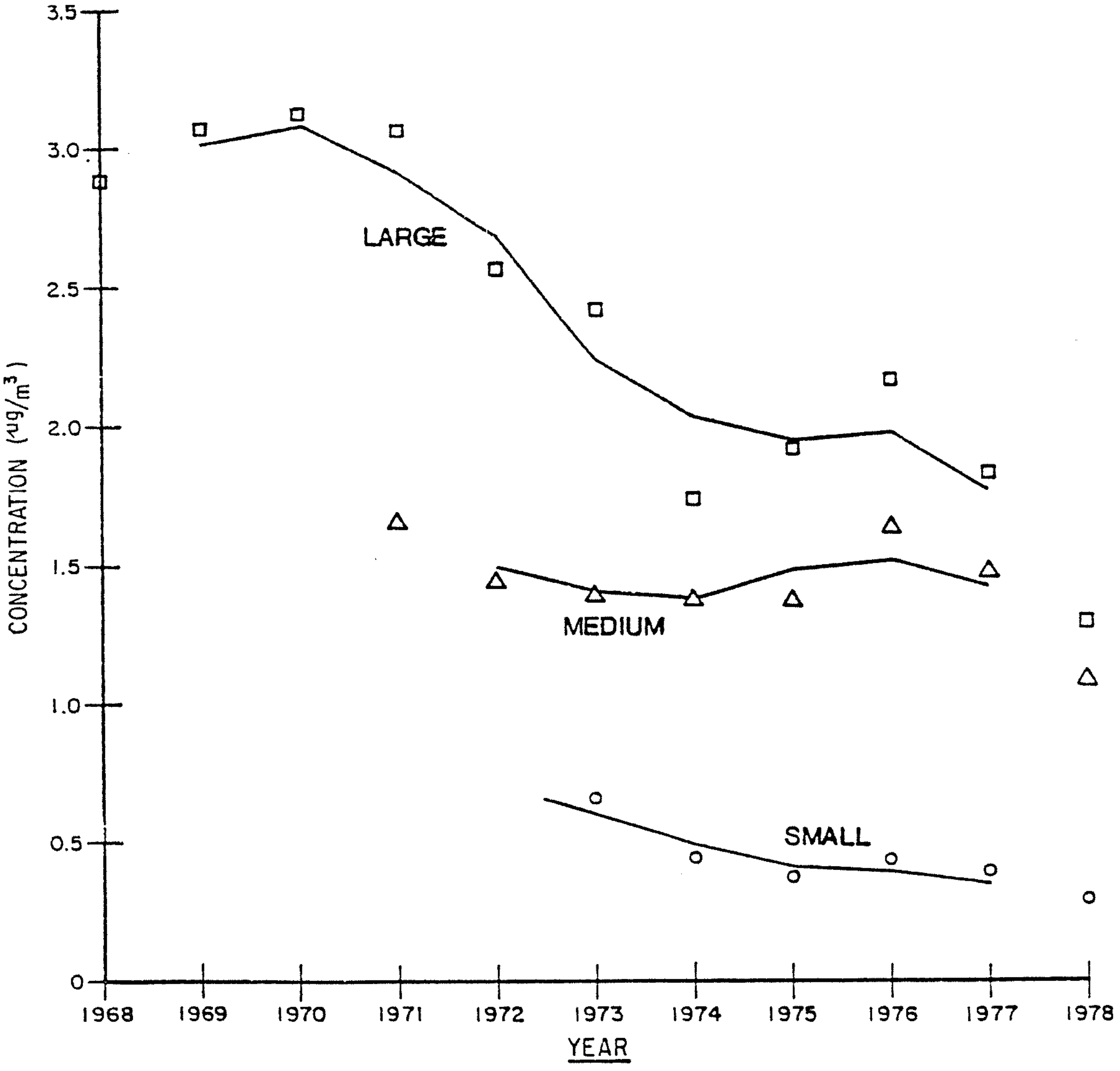

Figure Legend:

Large - City population greater than 500,000; composite of date from Los Angeles, San Diego, and San Jose; □ represents the annual mean.

Medium - City population from 50,000 to 500,000; composite of data from Bakersfield, Sacramento, and Santa Barbara; Δ represents the annual mean.

Small - City population less than 50,000; composite of data from El Centro and Lakeport; ○ represents the annual mean.

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Source: Air Resources Board, "Trends in Atmospheric Lead Concentrations", Vol. X, No. 2 Edition of Air Quality Data.

Appendix B also contains Tables 27-6, 27-7, and 27-8 which are mobile source emissions inventories for the years 1975, 1976, and 1977. The inventory is by county and broken into five categories of vehicles: light-duty passenger (LDP), light-duty truck (LDT), medium-duty truck (MDT), heavy-duty gasoline trucks (HDG), and motorcycles (MCY).

A summary of emissions from point sources identified as emitting as much as one ton per year is presented in Table 27-9 (Appendix B). These sources include secondary lead smelters; iron cupolas; steel, brass, and bronze furnaces; battery manufacturers; and coal and oil combustion. Only two stationary sources, both in the South Coast Air Quality Management District, were identified to have emissions of over 5 tons of lead per year.

C. Future Emissions and Air Quality

Future emissions of lead into the environment are projected to decrease dramatically primarily due to the previously discussed state regulations limiting the average lead content of gasoline. The lead levels in the state regulations were originally based on attainment of the state ambient air quality standard for lead and on the assumption that the lead level in air is directly proportional to the average lead content in gasoline. In 1963, the average amount of lead in gasoline was estimated at 2.32 gm/gal.* By 1970, the average lead content had risen to 2.59 gm/gal. With the introduction of low lead and unleaded gasolines, however, the average lead content dropped to 1.85 gm/gal in 1974. The state regulation will reduce overall lead content to 0.52 gm/gal in 1982.

As recommended by the EPA, a proportional rollback model was employed for all areas of the state as a preliminary analysis. An explanation of the specific modeling techniques employed is included in Appendix A. Table 27-4 lists the results of the air quality analysis and shows that all areas of California except Fresno and Los Angeles Counties will attain the NAAQS by 1982. It also shows that Fresno and Los Angeles will not attain the standard by 1984 without additional controls. Tables 27-10 and 27-12 (Appendix B) are the projected mobile source emissions inventories for 1982 and 1984, respectively. A more complete description of the method used to project emissions is included in Appendix B.

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*California State Department of Public Health, "Lead in the Environment and Its Effects on Humans," March 1967.